TRUCK HAULAGE AT AN IRON MINE IN THE ADIRONDACK MOUNTAINS, NEW YORK

BY ROBERT S. SANFORD

* * * * * * * * * * **Information Circular 7629**

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SUMMARY

This paper deals with truck haulage methods and costs at one of the many open-cut mines that are replacing rail haulage with heavy-duty trucks. At this mine, ore is trucked to a crushing plant centrally located within one of the open-cuts.

The requirements for efficient low-cost truck haulage are: Good trucks designed for heavy loads, adequate truck maintenance, smooth roads, and well-trained truck drivers.

The weighted average cost of hauling a long ton of ore to the crusher and the waste to the dump was reduced from $0.1993 in 1948 to $0.1114 during the last half of 1949. This corresponds to a cost per ton-mile of $0.0864.

The object of the Bureau of Mines and the mining companies that are cooperating in this investigation is to develop information on truck-haulage methods and costs for the benefit of those who are interested in improving mining practices.

At the mine under discussion, an intensive study of methods to improve haulage and lower costs is being continued.

INTRODUCTION

This paper is one of a series undertaken by the Bureau of Mines, to describe current practices in truck haulage of ore and waste at various mines.

ACKNOWLEDGMENTS

The Bureau of Mines is indebted to the staff of the mining company operating this mine for assistance in gathering information on the operation and to the executives of the company for permission to publish the information in this information circular.

This investigation was under the general supervision of McHenry Mosier, chief, Mining Development Branch, Minerals-Technology Division, Region VIII, Bureau of Mines.

CLIMATE

The climate of the mine is characteristic of the Adirondack Mountains. The 50-year average temperatures for Lake Placid, near the center of the mountains, are as follows: Mean annual temperature, 39.3°F.; average maximum temperature, 50.2°F.; average minimum temperature, 28.6°F. The highest temperature ever

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recorded is 96°F. and the lowest ever recorded -39°F. The average precipitation is 39.36 inches, which includes 129.1 inches of snow. The heaviest snowfall is in January and averages 25.8 inches.

The company has made adequate preparation for cold weather and operates the mines, the concentrator, and the sintering plant throughout the year.

MINING METHODS

The ore body is over 12,000 feet long and averages about 400 feet wide. The best ore is along the hanging wall.

The conventional bench system of open-cut mining is being used with benches 50 to 60 feet high (see fig. 1). Blast holes are sunk with churn and wagon drills. Secondary drilling or blockholing is done with sinker drills. Diesel-powered air compressors, 310 and 500 c.f.m., have been mounted on trucks to provide a mobile supply of compressed air (see fig. 2).

The mine is operated three shifts a day 7 days a week. The day shift strips and hauls the waste, using approximately seven trucks. Ore is mined on the afternoon and night shifts and is hauled with six to nine trucks.

The wage rates for mine, garage, and crusher employees are shown in table 1.

TABLE 1. - Mine, crusher, and garage wage rates, January 1950

Classification	Day Shift Rate, per hour
Shovel operator, 1st class	$1.77
Shovel operator, 2d class	1.66
Shovel operator, 3d class	1.55
Shovel oiler, 1st class	1.33
Shovel oiler, 2d class	1.28
Pit man	1.19
Tractor operator, 1st class	1.33
Tractor operator, 2d class	1.28
Truck driver instructor	1.34
Truck driver, heavy duty, 1st class	1.28
Truck driver, heavy duty, 2d class	1.23
Churn drill operator	1.28
Churn drill helper	1.23
Sinker-drill operator, 1st class	1.23
Sinker-drill operator, 2d class	1.19
Wagon-drill operator, 1st class	1.23
Wagon-drill operator, 2d class	1.19
Blaster, 1st class	1.41
Blaster, 2d class	1.28
Dumpman	1.14
Leader - garage	1.54
Auto mechanic, 1st class	1.47
Auto mechanic, 2d class	1.41
Auto mechanic, 3d class	1.34

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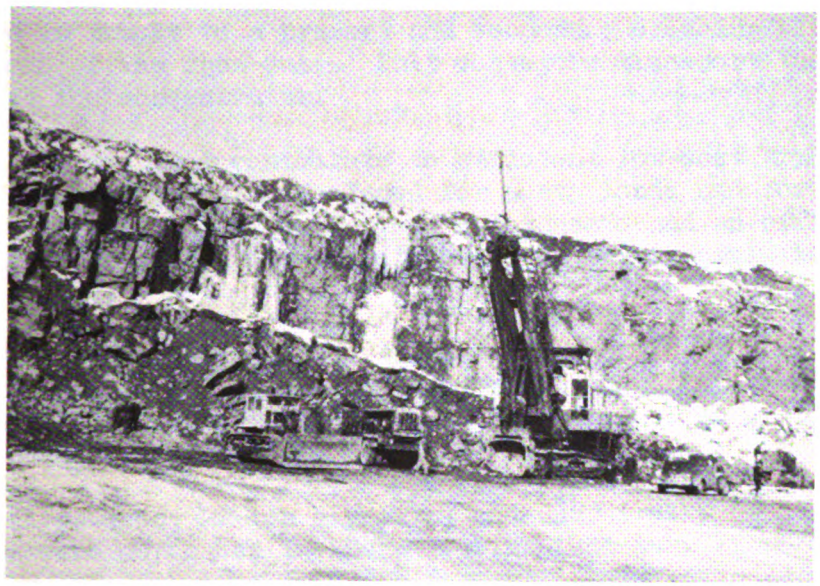

Figure 1. - Open cut mine.

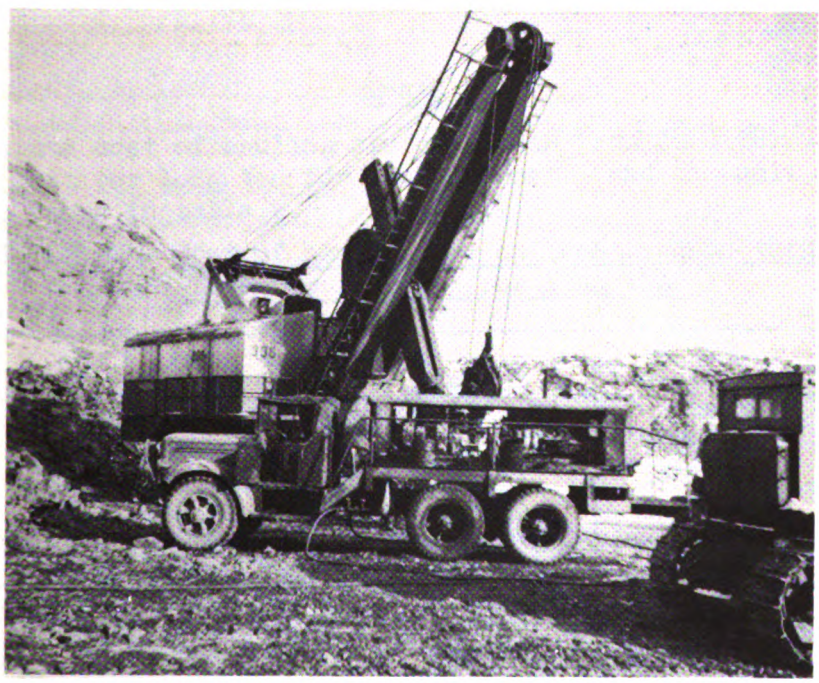

Figure 2. - Motorized air compressor.

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TRUCK HAULAGE

Heavy-duty ore trucks are replacing rail haulage in many open-cut mines and even in a few underground mines. At the iron mine discussed in this report, the ore is hauled in trucks to a primary and secondary crushing plant centrally located within one of the open-cuts. Belt conveyors transport the ore from the crushing plant to the concentrator.

Among the factors that contribute to efficient low-cost truck hauling are: (1) Good trucks correctly designed for heavy loads and for the impact of loading with power shovels; (2) good truck maintenance and an efficient repair shop; (3) smooth roads adequately maintained; and (4) careful, well-trained truck drivers.

The physical characteristics of the magnetite ore have a marked effect on the design and maintenace of haulage equipment. Magentite, which has a hardness of 5.5 to 6.5, is very abrasive. It has a specific gravity of 5.0 and weighs 311 pounds a cubic foot.

Five Diesel-powered, 22-ton capacity, end-dump trucks each using six heavy-duty tires were purchased in 1948. During that year 12 percent of the ore was hauled in end-dump trucks and 88 percent in side-dump tractor-trailers. From January to May 1949, 21 percent of the ore was hauled in end-dump trucks and 79 percent in tractor-trailers. Six additional end-dump trucks each with a capacity of 22 tons, were purchased in May 1949 (see appendix for specifications). From June to December 1949, 96 percent of the ore was hauled in end-dump trucks and 4 percent in tractor-trailers.

Costs

The aggregate cost of hauling ore and waste from June through December 1949, the unit cost per long ton for ore and waste, and the unit cost per long ton for ore are shown in table 2.

TABLE 2. - Cost of hauling ore and waste, June thru December 1949 1/, per long ton

	Amount	Ore and waste	Ore
Operating labor	$ 38,773	0.0247	0.0313
Operating supplies	46,518	.0296	.0376
Repair and maintenance labor	49,132	.0313	.0397
Repair and maintenance supplies	37,521	.0239	.0303
Miscellaneous labor	73	-	.0001
Miscellaneous supplies	1,440	.0009	.0012
Social security tax	1,554	.0010	.0013
Sub Totals:	$175,011	.1114	.1413
	Long tons		
Ore hauled	1,238,367		
Waste rock hauled	180,538		
Waste dirt hauled	150,976		
Total ore and waste	1,569,881		

1/ Depreciation is not included.

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Note: During the last 7 months of 1949, ore haulage cost $0.125 (approx.) per ton mile, ore and waste, cost $0.0864 per ton mile, and trucks averaged about 29 percent overload. During 1949 new tires cost $42,185 and the cost of tire repairs averaged about $1,700 per month.

The truck operating hours for the last 8 months of 1949, the mechanic man-hours on truck repair, and the mechanic man-hours per operating hour are shown in table 3.

December, 1949

TABLE 3. - Mechanic man-hours per truck operating hour

		Truck number					
		121	122	123	124	125 1/	126 2/
Truck operating hours	7 mo. to Dec.	1,474.5	1,317.5	1,076.5	1,854	1,281	2,496.5
	December	332.5	186.5	147.5	184.5	340	403
	8 mo. total	1,807	1,504	1,224	2,038.5	1,621	2,899.5
Mechanic-Man-Hours	7 mo. to Dec.	719.5	943	807.5	1,129	975.5	449.5
	December	76	252.5	190	155	145	154
	8 mo. total	795.5	1,195.5	997.5	1,284	1,120.5	603.5
Mech. Man-Hr. per - operating hour	7 mo. to Dec.	0.49	0.72	0.75	0.61	0.76	0.18
	December	.23	1.35	1.29	.84	.43	.38
	8 mo. average	.44	.79	.81	.63	.69	.30

		Truck number				
		127	128	129	130	131
Truck operating hours	7 mo. to Dec.	2,502	2,625.5	2,701	2,480.5	2,651.5
	December	472.5	307	532.5	509.5	547
	8 mo. total	2,974.5	2,932.5	3,233.5	2,990	3,198.5
Mechanic-Man-Hours	7 mo. to Dec.	726	656	616	624	427.5
	December	159.5	185.5	84.5	144	119.5
	8 mo. total	885.5	841.5	700.5	768	547
Mech. Man-Hr. per - operating hour	7 mo. to Dec.	0.29	0.25	0.23	0.25	0.16
	December	.34	.60	.16	.28	.22
	8 mo. total	.30	.29	.21	.26	.17

1/ Trucks 121 to 125, inclusive, started service in January 1948.
2/ Trucks 126 to 131, inclusive, started service in May 1949.

The frequency of the more important truck-maintenance jobs is listed in table 4.

The same drivers are always assigned to the same truck. Tables 3 and 4 indicate which drivers had faulty driving technique; for example, it appears that one of the drivers on truck 125 was riding the foot brake.

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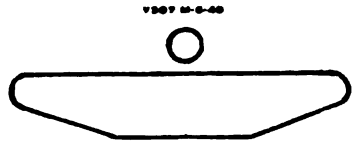

TIRE CHANGE TAG

Tire Serial No. _____ Tag No. _____

The upper portion of this tag must be filled out by Mechanic and attached to tire when removed from truck, and must not be detached until reinstalled on truck. When reinstalled, fill out, detach, and send to office with daily report. See additional instructions below:

	Removed	Applied
Trailer No.		
Truck No.		
Date		
Shift		
Wheel Position		

CAUSE FOR REMOVAL:

_____

_____

Mechanic's Name _____

	Removed	Applied
Trailer No.		
Truck No.		
Date		
Wheel Position		
Meter Reading		

Cause for Removal _____

_____

Mechanic's Name _____

Tire No. _____ Tag No. _____

The lower portion of this tag must be filled out at time of removal of this tire from truck and sent to office with daily report.

DAILY TRUCK DRIVER'S REPORT

Shift _____ Date _____

Truck No. _____ Trailer No. _____

Shovel Number Served _____

Number of Loads Ore _____

Number of Loads Rock Stripping _____

Number of Loads Surface Stripping _____

Number of Hours Worked _____

Gallons Fuel Oil _____ Quarts Oil _____

Speedometer Reading Beginning Shift _____

Speedometer Reading End of Shift _____

Total Mileage for Shift _____

Delays—

Tire Failure _____ Hrs. _____ Min.

Repairs:—

_____ _____ Hrs. _____ Min.

_____ _____ Hrs. _____ Min.

Remarks:— _____

_____

_____

Driver _____

Figure 3. - Forms for truck driver's report and tire record.

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TABLE 4. - Truck maintenance frequency, May - December 1949

Type of work		Truck numbers										
		121	122	123	124	125	126	127	128	129	130	131
Foot brake	Adjust	4	4	5	4	9	2	5	4	6	7	6
	Reline	1	1	1	0	1	2	1	1	0	1	2
Emergency stop	Adjust	6	5	5	2	7	1	4	6	6	4	5
	Reline	0	0	0	1	3	0	2	0	1	1	1
Tires	Check	1	0	3	1	2	1	1	5	0	2	1
	Change	5	1	2	4	3	6	8	3	4	6	8
Drive shaft		4	3	6	2	8	4	5	2	6	1	3
Hoist trouble		1	1	1	0	0	2	1	2	3	1	1
Operating hours		332.5	186.5	147.5	184.5	340	403	472.5	307	532.5	509.5	547

To facilitate haulage cost accounting the company has a number of forms as follows: (1) A Supply Department form that lists date, requisition, and account numbers, where used, quantity, description, and catalogue number. (2) A Labor Record, Truck Repairs form that lists date, truck number, make, type of work done, and hours required; also whether the job is maintenance, overhaul, inspection, or repair owing to an accident. (3) Tire-Change Tag and Daily Truck Driver's Report, (fig. 3). On the back of the Tire-Change Tag is a tire identification chart. It lists the left front tire as No. 1, right front tire No. 2, left rear wheel No. 3, and right rear wheel No. 4. For the dual tires, A is the outside tire and B the inside tire.

Maintenance

The company recently has completed a large, well-arranged garage equipped with an overhead traveling crane. The garage is divided into a tire-repair shop, an engine-repair shop, a storeroom, and a wing for lubrication and service.

At the end of each operating shift the fuel and lubricating oil and lights are checked on each truck, the odometer reading is recorded, and the tire pressure is checked.

Once a week the following inspections and maintenance operations are performed: (1) Change the engine lubricating oil; (2) change oil in the bottom of the air cleaner; (3) check oil level in hydraulic hoist; (4) check the cooling system, (fan and water pump belts and radiator and water hoses); (5) check wheel alinement, tie rod ends, steering drag links, front spindles for visible cracks, and tire and wheel nuts; (6) test the brake adjustments and the clutch-pedal clearance; (7) check the center bearing on the drive shaft; (8) inspect the frame and body for loose or missing nuts and visible cracks; and (9) inspect for oil leaks.

Once a month the valve covers are taken off to check crosshead lock nuts, valve clearance, and injector clearance.

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The repair foreman keeps a notebook listing all accidents, major repairs, and experimental data on each truck. Extra unit assemblies for the trucks and engines are kept on hand ready to be installed with a minimum loss of time. All fuel and lubricating oil are piped from the tanks to the trucks. This serves the dual purpose of keeping the oil and the garage clean.

The method of changing a rear tire is shown in figure 4. The truck is lifted with the crane and wooden blocks placed under the body as a safety precaution.

Tires are placed in a steel box before being inflated for the first time. (see fig. 5). The bulges in the side of the box were caused by rims that have blown off.

To remove the heavy snowfall characteristic of the region, a large snow plow mounted on a four-wheel drive truck is used. (see fig. 6).

APPENDIX

Specifications of the End-dump Ore Trucks

A brief résumé of the more important truck specifications that influence haulage efficiency and notes on experimental data follow:

Engine

The trucks are equipped with 6-cylinder, four-cycle Diesel engines that have 275 brake horsepower at 2,100 r.p.m., loaded, and a maximum torque of 710 foot-pounds at 1,600 r.p.m.

Transmission

The complete transmission and clutch are mounted integrally with the engine. There are five speeds forward and one reverse, ranging, loaded, from 3.1 to 32.3 m.p.h.

Brakes

The trucks are equipped with air-operated brakes on the front and drive wheels. An emergency brake is mounted on the drive shaft. Most of the ore hauling to date has been down hill; hence, brake maintenance and brake shoe replacement have been expensive. It has been found that brake shoe life can be doubled by using a woven shoe on the anchor end and a molded shoe on the cam end of the brake shoe assembly, rather than two woven or two molded shoes on an assembly.

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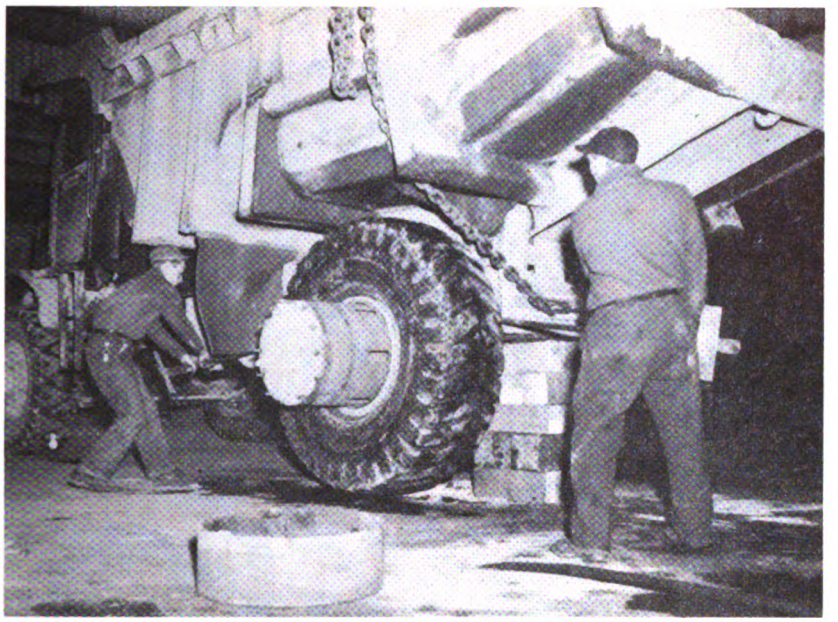

Figure 4. - Changing a rear tire.

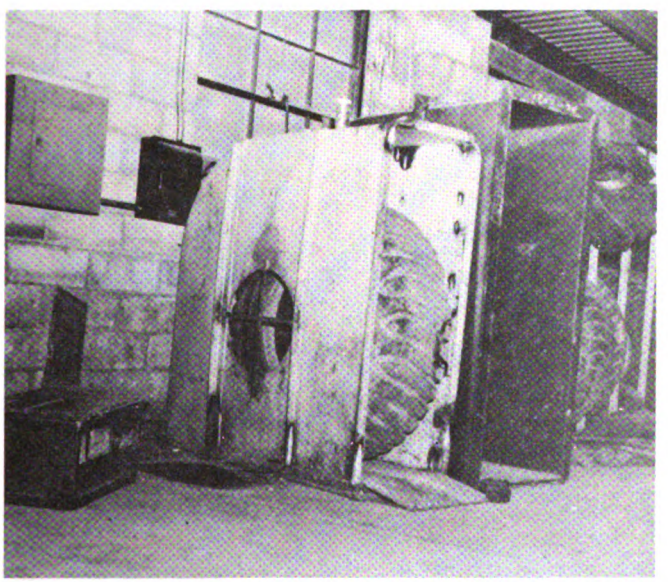

Figure 5. - Safety steel tire inflating box.

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Figure 6. - Snow plow.

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Body and Frame

The trucks have double bottoms with thick oak planking between 3/8-inch-thick plates. Front and side plates are 3/8 inch thick. Bodies are built on two channel sills. Side plates are rigidly braced with five sturdy box-section supports on each side. Heavy angles are welded on the top edges of the body and on the protective canopy that extends over the cab. The mining company has found that the 3/8-inch plates in the bottom and sides of the trucks do not furnish enough protection against the impact and abrasion of the ore. To give added protection to the body, heat-treated alloy steel plates are welded on the sides and heat-treated alloy steel strips are welded on the bottom. The strips are 6 inches wide, 1 inch thick, and spaced 4 inches apart.

The frame side members are wide-flanged, deep-sectioned I beams the full length of the truck. Heavy tubular and box-section members stiffen the frame and keep it straight. The body-pivot shaft turns in rubber-mounted bushings, which relieve the frame of twisting strains during loading and dumping. Eight rubber disk cushions provide for all motion between body and frame and cushion the impact of loading heavy ore. There is no metal to metal contact between the body and the frame.

Steering and Drive Axle

The trucks are equipped with hydraulic power steering that assures easy, positive steering under all road conditions.

All working parts of the drive axle are completely enclosed in an oil bath. Wheels are hollow cast steel. The total standard reduction is 17.9:1. Primary reduction consists of conventional spiral, bevel, ring gear, pinion, and differential. Secondary reduction consists of two floating planetary gear sets and an internal ring gear in each wheel. All of the rear axle load is carried on heavy-duty tapered roller bearings mounted on hollow axle spindles. Shafts and gears are entirely free of vehicle and payload weight. The planetary reductions at each wheel permit minimum gear reduction in the transmission and differential; hence, much lighter loads are imposed on all parts between the engine and the planetary gears.

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